CLAIMS

I claim:

1. A method for forming a biological chemical tag, the method comprising the steps of:

providing at least one double stranded DNA molecule;

denaturing at least a portion of the at least one double stranded DNA molecule; and

attaching to at least one nucleotide in the at least one denatured portion of the at least one double stranded DNA molecule at least one chemical moiety that prohibits recrystallization of the at least one denatured portion to which the at least one chemical moiety is attached.

2. The method according to claim 1, wherein the at least one chemical moiety is attached to at least one selected nucleotide of the at least one DNA molecule.

3. The method according to claim 1, wherein the at least one chemical moiety is attached to the at least one nucleotide in the at least one denatured portion of the at least one DNA molecule by at least one hydrogen bond.

4. The method according to claim 1, wherein the at least one chemical moiety is attached to the at least one nucleotide in the at least one denatured portion of the at least one DNA molecule by at least one covalent bond.

5. The method according to claim 1, further comprising the steps of:

providing a substrate upon which the at least one DNA molecule may be arranged and denatured; and

arranging the at least one DNA molecule on the substrate prior to denaturing at least a portion of the DNA molecule.

6. The method according to claim 5, further comprising the step of:

providing regions of the substrate having different wetting properties.

7. The method according to claim 6, further comprising the step of:

depositing a solution on the substrate, the solution being able to denature DNA.

8. The method according to claim 7, wherein the

solution is deposited on the entire substrate.

9. The method according to claim 7, wherein the solution is aqueous.

10. The method according to claim 7, wherein the solution has a high dielectric constant.

11. The method according to claim 7, wherein the solution includes at least one salt.

12. The method according to claim 7, wherein the solution includes a polar solvent.

13. The method according to claim 6, wherein the regions having different wetting properties are provided in a plurality of alternating lines.

14. The method according to claim 13, wherein the lines are provided in a first type having a first wetting property and a second type having a second wetting property.

15. The method according to claim 14, wherein the lines are provided such that all of the lines of the first

type have a first width and all of the lines of the second type have a second width.

16. The method according to claim 15, wherein the lines of the first type are provided with a width of about 10 nm to about 1000 nm.

17. The method according to claim 15, wherein the lines of the second type are provided with a width of about 10 nm to about 10000 nm.

18. The method according to claim 14, wherein all of the lines of one type are provided with a width less than all of the lines of the other type.

19. The method according to claim 14, wherein lines of one type are provided such that they will tend to retain a solution deposited on them.

20. The method according to claim 19, wherein the solution is aqueous.

21. The method according to claim 19, wherein the solution includes a polar solvent.

22. The method according to claim 19, wherein the solution has a high dielectric constant.

23. The method according to claim 19, wherein the solution includes at least one salt.

24. The method according to claim 14, wherein the lines are provided such that lines of one type will tend to retain at least a portion of a DNA molecule arranged on the substrate.

25. The method according to claim 5, further comprising the step of:

providing at least one channel in the substrate.

26. The method according to claim 25, wherein the at least one channel is provided with a depth of about 10 nm to about 500 nm.

27. The method according to claim 25, wherein the at least one channel is provided with a width of about 10 nm to about 10000 nm.

28. The method according to claim 5, further

comprising the step of:

providing a plurality of channels in the substrate.

29. The method according to claim 28, wherein the channels are provided with a depth of about 10 nm to about 500 nm.

30. The method according to claim 28, wherein all of the channels are all provided with substantially the same depth.

31. The method according to claim 28, wherein the channels are provided with widths of about 10 nm to about 10000 nm.

32. The method according to claim 28, wherein the all of the channels are provided with substantially the same width.

33. The method according to claim 28, wherein the channels are provided such that they are separated from each other by a distance of about 10 nm to about 1000 nm.

34. The method according to claim 28, wherein the

channels are provided with openings having a minimum width of about 10 nm to about 10000 nm.

35. The method according to claim 28, further comprising the step of:

depositing a solution in the channels.

36. The method according to claim 35, wherein the channels are provided such that they have a depth and a width sufficient to accommodate an amount of the solution sufficient to result in a selected amount of contact between the solution and the at least one DNA molecule arranged on the substrate to result in a selected amount of denaturing of the at least one DNA molecule and the channels are separated by lands that have a width sufficient to hold the at least one DNA molecule.

37. The method according to claim 28, wherein the channels are provided in the substrate according to a method comprising the steps of:

depositing a first layer of a photoresist on the substrate;

selectively exposing the first layer of photoresist to wavelengths of radiation that the photoresist is sensitive

to;

developing the photoresist;

etching the substrate exposed by development of the photoresist; and

removing photoresist not removed by the developing.

38. The method according to claim 37, further comprising the step of:

treating the substrate with a material to make at least a portion of a surface of the substrate at least partially hydrophilic prior to exposure of the substrate.

39. The method according to claim 38, wherein the material is HF.

40. The method according to claim 37, wherein the photoresist has a high silicon content.

41. The method according to claim 37, wherein the etching of the substrate is carried out with a reactive ion etch.

42. The method according claim 37, wherein the substrate is etched with a Cl_2, low pressure plasma.

43. The method according to claim 37, further comprising the step of:

exposing at least a portion of the substrate to a material to make the substrate at least partially hydrophilic after etching of the substrate and prior to removal of the photoresist not removed by the developing.

44. The method according to claim 28, wherein the channels are provided such that they are all parallel.

45. The method according to claim 43, wherein the material that at least a portion of the substrate is exposed to is water.

46. The method according to claim 28, wherein the substrate is a silicon wafer.

47. The method according to claim 46, wherein the silicon wafer is a <100>, n-doped silicon wafer.

48. The method according to claim 47, further comprising the step of:

depositing a layer of Si_3N_4 or SiO_2 on the substrate;

depositing a first layer of a photoresist on the substrate;

selectively exposing the first layer of photoresist to wavelengths of radiation that the photoresist is sensitive to;

developing the photoresist;

etching Si_3N_4 or SiO_2 exposed by developing of the photoresist;

removing photoresist not removed by the developing; and

etching the substrate exposed by development of the photoresist.

49. The method according to claim 48, further comprising the step of:

exposing the substrate to a material to make at least a portion of a surface of the substrate hydrophilic.

50. The method according to claim 48, wherein the photoresist is applied by spin casting.

51. The method according to claim 48, wherein the Si_3N_4 or SiO_2 is etched utilizing wet chemistry or reactive ion etching.

52. The method according to claim 48, wherein the Si_3N_4 or SiO_2 is etched utilizing HF.

53. The method according to claim 48, wherein the substrate is isotropically etched.

54. The method according to claim 52, wherein the substrate is etched with CF_4 plasma.

55. The method according to claim 49, wherein the material making at least a portion of a surface of the substrate hydrophilic includes at least one member of the group consisting of sulfuric acid and hydrogen peroxide.

56. The method according to claim 49, further comprising the step of:

depositing at least one metal on the substrate or on any material deposited on the substrate.

57. The method according to claim 56, wherein the at least one metal is deposited on at least a portion of the surface area within the channels and on at least a portion of the Si_3N_4 or SiO_2 remaining on the substrate.

58. The method according to claim 56, wherein the at least one metal is a noble metal.

59. The method according to claim 56, wherein the at least one metal is gold.

60. The method according to claim 57, further comprising the step of:

removing selected portions of the metal.

61. The method according to claim 60, wherein the metal is removed from the Si_3N_4 or SiO_2.

62. The method according to claim 60, wherein the metal is removed by exposing it to at least one material selected from the group consisting of Hg and Ga.

63. The method according to claim 28, further comprising the steps of:

providing a multi-layer structure that includes a layer of a semiconductor material, a first layer of a dielectric material on a first surface of the layer of semiconductor material, a second layer of a dielectric material on a second surface of the layer of semiconductor material

opposite the first surface, a first photoresist layer on the first layer of dielectric material, and a second photoresist layer on the second layer of dielectric material;

selectively exposing the first layer of photoresist and the second layer of photoresist to wavelengths of radiation that the first layer of photoresist and the second layer of photoresist are sensitive to;

developing the first layer of photoresist and the second layer of photoresist;

selectively etching the first layer of dielectric material and the second layer of dielectric material;

removing portions of the first layer of photoresist and the second layer of photoresist not removed by the developing;

selectively etching the layer of semiconductor material utilizing one of the layers of dielectric material as a mask;

selectively etching the layer of semiconductor material utilizing another of the layers of dielectric material as a mask; and

remove the other layer of dielectric material.

64. The method according to claim 63, wherein the layer of semiconductor material is <100> silicon.

65. The method according to claim 63, wherein one of the layers of dielectric material is SiO_2 and the other of the layers of dielectric material is Si_3N_4.

66. The method according to claim 63, wherein the layers of dielectric material are etched by reactive ion etching.

67. The method according to claim 63, wherein the layers of dielectric material are etched with different reactive ion etch plasmas.

68. The method according to claim 63, wherein the layer of semiconductor material is anisotropically etched.

69. The method according to claim 63, wherein the other layer of dielectric material is removed with phosphoric acid.

70. The method according to claim 1, wherein the at least one chemical moiety attaches to the at least one nucleotide with at least one hydrogen bond or at least one covalent bond.

71. The method according to claim 1, wherein the at least one chemical moiety includes at least one nucleotide.

72. The method according to claim 1, wherein the at least one chemical moiety includes at least two different moieties.

73. The method according to claim 72, wherein at least one of the moieties is capable of bonding to the at least one nucleotide of the at least one DNA molecule.

74. The method according to claim 1, wherein the at least one chemical moiety includes at least one acid group or salt of an acid group.

75. The method according to claim 1, wherein the at least one chemical moiety bonds with at least one amide group on the at least one DNA molecule.

76. The method according to claim 71, wherein the at least one chemical moiety includes two nucleotides.

77. The method according to claim 71, wherein the at least one chemical moiety includes guanine and cytosine or

thymine and adenine.

78. The method according to claim 1, wherein the at least one chemical moiety includes at least one chemical moiety that makes the location of the at least one denatured portion of the at least one DNA molecule detectable.

79. The method according to claim 78, wherein the at least one chemical moiety makes the location of the at least one denatured portion of the at least one DNA molecule visually detectable.

80. The method according to claim 78, wherein the at least one chemical moiety makes the location of the at least one denatured portion of the at least one DNA molecule detectable upon exposure to electromagnetic radiation.

81. The method according to claim 78, wherein the at least one chemical moiety makes the location of the at least one denatured portion of the at least one DNA molecule detectable includes at least one dye.

82. The method according to claim 80, wherein the at least one chemical moiety makes the location of the at least

one denatured portion of the at least one DNA molecule detectable emits electromagnetic radiation in response to the exposure to electromagnetic radiation.

83. The method according to claim 82, wherein the at least one chemical moiety makes the location of the at least one denatured portion of the at least one DNA molecule detectable emits electromagnetic radiation in at least one of the ultraviolet and visible portions of the electromagnetic spectrum.

84. The method according to claim 78, wherein the at least one chemical moiety includes at least one chemical moiety that makes the location of the at least one denatured portion of the at least one DNA molecule detectable under a microscope.

85. The method according to claim 73, further comprising the step of:

attaching to the at least one chemical moiety capable of bonding to the at least one nucleotide at least one chemical moiety that makes the location of the at least one denatured portion of the at least one DNA molecule detectable.

86. The method according to claim 85, wherein the at least one chemical moiety that makes the location of the at least one denatured portion of the at least one DNA molecule detectable includes a polymer, to which at least one chemical moiety that makes the location of the at least one denatured portion of the at least one DNA molecule detectable is attached.

87. The method according to claim 86, wherein the at least one chemical moiety that makes the location of the at least one denatured portion of the at least one DNA molecule detectable is attached to the polymer with a functional group attached to the polymer chain.

88. The method according to claim 1, wherein the at least one denatured portion of the DNA and the at least one chemical moiety create writable segments on the DNA molecule, the method further comprising the steps of:

assigning a first value to a segment of the DNA molecule that includes the chemical moiety; and

assigning a second value to a segment of the DNA molecule that does not include the chemical moiety.

89. The method according to claim 88, wherein

information may be represented in the values assigned to the segments of the DNA molecule.

90. The method according to claim 88, wherein the DNA molecule has a length of about 10 mm and about 10000 portions of the DNA molecule are assigned values.

91. The method according to claim 1, further comprising the steps of:

determining locations where the at least one chemical moiety is attached to the DNA molecule; and

analyzing the detected locations to determine a sequence of the DNA molecule.

92. The method according to claim 1, wherein the DNA molecule is denatured by applying heat to the at least one portion to be denatured.

93. The method according to claim 56, further comprising the step of:

applying a current to the at least one metal to raise the temperature of a portion of the DNA molecule in the vicinity of the channel that the at least one metal is deposited in to denature.

94. The method according to claim 28, further comprising the step of:

providing at least one structure overhanging openings of the channels.

95. The method according to claim 94, wherein the overhanging structure is made of a dielectric material.

96. The method according to claim 95, wherein the dielectric material is SiO_2 or Si_3N_4.

97. The method according to claim 94, further comprising the step of:

depositing at least one metal on the substrate or on any material deposited on the substrate.

98. A structure, comprising:

a DNA molecule including at least one denatured portion; and

at least one chemical moiety attached to at least one nucleotide in at least one denatured portion the DNA, wherein the at least one chemical moiety prevents recrystallization of the at least one denatured portion to which the at least one chemical moiety is attached.

99. The structure according to claim 98, wherein the at least one chemical moiety is attached to at least one selected nucleotide of the at least one DNA molecule.

100. The structure according to claim 98, wherein the at least one chemical moiety is attached to the at least one nucleotide in the at least one denatured portion of the at least one DNA molecule by at least one hydrogen bond.

101. The structure according to claim 99, wherein the at least one chemical moiety is attached to the at least one nucleotide in the at least one denatured portion of the at least one DNA molecule by at least one covalent bond.

102. The structure according to claim 98, wherein the at least one chemical moiety is attached to the at least one nucleotide with at least one hydrogen bond or at least one covalent bond.

103. The structure according to claim 98, wherein the at least one chemical moiety includes at least one nucleotide.

104. The structure according to claim 98, wherein the

at least one chemical moiety includes at least two different moieties.

105. The structure according to claim 104, wherein at least one of the moieties is capable of bonding to the at least one nucleotide of the at least one DNA molecule.

106. The structure according to claim 98, wherein the at least one chemical moiety includes at least one acid and at least one alcohol.

107. The structure according to claim 98, wherein the at least one chemical moiety is attached to at least one amide group on the at least one DNA molecule.

108. The structure according to claim 103, wherein the at least one chemical moiety includes two nucleotides.

109. The structure according to claim 103, wherein the at least one chemical moiety includes guanine and cytosine or thymine and adenine.

110. The structure according to claim 98, wherein the at least one chemical moiety includes at least one chemical

moiety that makes the location of the at least one denatured portion of the at least one DNA molecule detectable.

111. The structure according to claim 109, wherein the at least one chemical moiety makes the location of the at least one denatured portion of the at least one DNA molecule visually detectable.

112. The structure according to claim 110, wherein the at least one chemical moiety makes the location of the at least one denatured portion of the at least one DNA molecule detectable upon exposure to electromagnetic radiation.

113. The structure according to claim 110, wherein the at least one chemical moiety makes the location of the at least one denatured portion of the at least one DNA molecule detectable includes at least one dye.

114. The structure according to claim 112, wherein the at least one chemical moiety makes the location of the at least one denatured portion of the at least one DNA molecule detectable emits electromagnetic radiation in response to the exposure to electromagnetic radiation.

115. The structure according to claim 114, wherein the at least one chemical moiety makes the location of the at least one denatured portion of the at least one DNA molecule detectable emits electromagnetic radiation in at least one of the ultraviolet and visible portions of the electromagnetic spectrum.

116. The structure according to claim 110, wherein the at least one chemical moiety includes at least one chemical moiety that makes the location of the at least one denatured portion of the at least one DNA molecule detectable under a microscope.

117. The structure according to claim 98, wherein the DNA molecule has a length of about 10 mm and about 10000 denatured portions.

118. The structure according to claim 117, further comprising:

a substrate upon which the at least one DNA molecule is arranged.

119. The structure according to claim 118, wherein the substrate includes regions having different wetting

properties.

120. The structure according to claim 119, further comprising:

a solution deposited on the substrate, wherein the solution is capable of denaturing the at least one DNA molecule.

121. The structure according to claim 120, wherein the solution is deposited on the entire substrate.

122. The structure according to claim 120, wherein the solution is aqueous.

123. The structure according to claim 120, wherein the solution has a high dielectric constant.

124. The structure according to claim 120, wherein the solution includes at least one salt.

125. The structure according to claim 120, wherein the solution includes a polar solvent.

126. The structure according to claim 119, wherein the

regions having different wetting properties are in a plurality of alternating lines.

127. The structure according to claim 126, wherein the lines include a first type having a first wetting property and a second type having a second wetting property.

128. The structure according to claim 126, wherein all of the lines of the first type have a first width and all of the lines of the second type have a second width.

129. The structure according to claim 126, wherein the lines of the first type have a width of about 10 nm to about 1000 nm.

130. The structure according to claim 126, wherein the lines of the second type have a width of about 10 nm to about 10000 nm.

131. The structure according to claim 126, wherein all of the lines of one type have a width less than all of the lines of the other type.

132. The structure according to claim 126, wherein

lines of one type tend to retain a solution deposited on them.

133. The structure according to claim 126, wherein lines of one type tend to retain at least a portion of the at least one DNA molecule on them.

134. The structure according to claim 118, further comprising:

at least one channel in the substrate.

135. The structure according to claim 134, wherein the at least one channel has a depth of about 10 nm to about 500 nm.

136. The structure according to claim 134, wherein the at least one channel has a width of about 10 nm to about 10000 nm.

137. The structure according to claim 118, comprising:

a plurality of channels in the substrate.

138. The method according to claim 137, wherein the channels have a depth of about 10 nm to about 500 nm.

139. The structure according to claim 137, wherein all of the channels have substantially the same depth.

140. The structure according to claim 137, wherein the channels have widths of about 10 nm to about 10000 nm.

141. The structure according to claim 137, wherein the all of the channels have substantially the same width.

142. The structure according to claim 137, wherein the channels are separated from each other by a distance of about 10 nm to about 1000 nm.

143. The structure according to claim 137, wherein the channels have openings having a minimum width of about 10 nm to about 10000 nm.

144. The structure according to claim 137, further comprising:

a solution deposited in the channels.

145. The structure according to claim 137, wherein the channels have a depth and a width sufficient to accommodate an amount of the solution sufficient to result in a selected

amount of contact between the solution and the at least one DNA molecule arranged on the substrate to result in a selected amount of denaturing of the at least one DNA molecule and the channels are separated by lands that have a width sufficient to hold the at least one DNA molecule.

146. The structure according to claim 137, wherein surfaces within the channels are hydrophilic and surfaces between the channels are less hydrophilic.

147. The structure according to claim 118, wherein the substrate includes at least one semiconductor material.

148. The structure according to claim 147, wherein the substrate is a silicon wafer.

149. The structure according to claim 147, wherein the substrate is a <100>, n-doped silicon wafer.

150. The structure according to claim 137, wherein all of the channels are parallel.

151. The structure according to claim 137, further comprising:

at least one metal arranged on a surface within the channels.

152. The structure according to claim 137, wherein the at least one metal is a noble metal.

153. The structure according to claim 137, wherein the at least one metal is gold.

154. The structure according to claim 137, wherein the channels are separated from each other by a portion of the substrate.

155. The structure according to claim 154, further comprising:

a portion of a dielectric material overhanging openings to the channels.

156. The structure according to claim 154, wherein the dielectric material overhanging openings to the channels is SiO_2 or Si_3N_4.

157. The structure according to claim 137, wherein the channels extend completely through the substrate.

158. The structure according to claim 153, further comprising:

a solution reservoir in which the substrate is arranged; and

a solution contained in the reservoir.

159. The structure according to claim 98, wherein the at least one denatured portion of the at least one DNA molecule includes about 40 base pairs to about 40,000 base pairs.